

WHAT IS CLAIMED IS:

1. A gripper assembly for anchoring a tool within a passage and for assisting movement of said tool within said passage, said gripper assembly being movable along an elongated shaft of said tool, said gripper assembly having an actuated position in which said gripper assembly substantially prevents movement between said gripper assembly and an inner surface of said passage, and a retracted position in which said gripper assembly permits substantially free relative movement between said gripper assembly and said inner surface of said passage, said gripper assembly comprising:

an elongated mandrel surrounding and configured to be longitudinally slidable with respect to said shaft of said tractor;

a first toe support longitudinally fixed with respect to said mandrel;

a second toe support longitudinally slidable with respect to said mandrel;

a flexible elongated toe having a first end pivotally secured with respect to said first toe support and a second end pivotally secured with respect to said second toe support so that said first and second ends of said toe have an at least substantially constant radial position with respect to a longitudinal axis of said mandrel;

a driver longitudinally slidable with respect to said mandrel, said driver being longitudinally slidable between a retraction position and an actuation position; and

a driver interaction element on a central region of said toe, configured to interact with said driver;

wherein longitudinal movement of said driver causes interaction between said driver and said driver interaction element substantially without sliding friction therebetween, said interaction varying the radial position of said central region of said toe, wherein when said driver is in said retraction position said central region of said toe is at a first radial distance from said longitudinal axis of said mandrel and said gripper assembly is in said retracted position, and when said driver is in said actuation position said central region of said toe is at a second radial distance from said longitudinal axis and said gripper assembly is in said actuated position.

2. The gripper assembly of Claim 1, wherein longitudinal movement of said driver causes a radial outward force to be applied to an inner surface of said central region of said toe.

3. The gripper assembly of Claim 1, wherein said second radial distance is greater than said first radial distance.

4. The gripper assembly of Claim 1, said driver comprising a slider element configured to slide along said mandrel, a roller being fixed to said slider element, said driver interaction element comprising a ramp on an inner surface of said toe, said roller configured to roll against said ramp.

5. The gripper assembly of Claim 1, said driver comprising a slider element configured to slide along said mandrel, said slider element having a ramped surface, said driver interaction element comprising a roller rotatably secured to said toe, said roller configured to roll against said ramped surface.

6. The gripper assembly of Claim 1, said driver comprising a slider element and a toggle, said slider element configured to slide along said mandrel, said toggle having a first end received within a first toggle recess of said slider element, said first end of said toggle rotatably maintained on said slider element, said driver interaction element comprising a second toggle recess in an inner surface of said toe, said toggle having a second end received within said second toggle recess, said second end of said toggle rotatably maintained on said toe.

7. The gripper assembly of Claim 1, said toe having a bending strength within the range of 60,000-350,000 psi.

8. The gripper assembly of Claim 1, said toe having a tensile modulus within the range of 1,000,000-15,000,000 psi.

9. The gripper assembly of Claim 1, wherein said toe comprises a single beam.

10. A gripper assembly for use with a tractor for moving within a passage, said gripper assembly being longitudinally slidable along an elongated shaft of said tractor, said gripper assembly having an actuated position in which said gripper assembly substantially prevents movement between said gripper assembly and an inner surface of said passage, and a retracted position in which said gripper assembly permits substantially free relative

movement between said gripper assembly and said inner surface of said passage, said gripper assembly comprising:

- an elongated mandrel configured to be longitudinally slidable with respect to said shaft of said tractor;

- a first toe support longitudinally fixed with respect to said mandrel;

- a second toe support longitudinally slidable with respect to said mandrel;

- a flexible elongated toe having a first end pivotally secured with respect to said first toe support and a second end pivotally secured with respect to said second toe support;

- a ramp having an inclined surface extending between an inner radial level and an outer radial level, said inner radial level being radially closer to the surface of said mandrel than said outer radial level, said ramp longitudinally slidingly engaged with said mandrel; and

- a roller rotatably secured to a center region of said toe, said roller configured to roll against said ramp;

wherein longitudinal movement of said ramp causes said roller to roll against said ramp between said inner and outer levels to vary the radial position of said center region of said toe between a radially inner position corresponding to said retracted position of said gripper assembly and a radially outer position corresponding to said actuated position of said gripper assembly.

11. The gripper assembly of Claim 10, wherein said inclined surface of said ramp is substantially straight with respect to said roller.

12. The gripper assembly of Claim 10, wherein said inclined surface of said ramp is substantially convex with respect to said roller.

13. The gripper assembly of Claim 10, wherein said first and second ends of said toe have an at least substantially constant radial position with respect to said mandrel.

14. The gripper assembly of Claim 10, where said toe comprises a single beam.

15. The gripper assembly of Claim 10, wherein said ramp is movable between first and second longitudinal positions relative to said mandrel, such that when said ramp is in said first position said roller is at said inner radial level and said gripper assembly is in said

retracted position, and such that when said ramp is in said second position said roller is at said outer radial level and said gripper assembly is in said actuated position.

16. The gripper assembly of Claim 15, further comprising a spring biasing said ramp toward said first longitudinal position thereof.

17. The gripper assembly of Claim 16, wherein said spring comprises a coil spring.

18. The gripper assembly of Claim 15, further comprising a piston longitudinally slidingly engaged with said mandrel and longitudinally fixed with respect to said ramp, such that said piston and said ramp are longitudinally fixed with respect to one another and move together longitudinally.

19. The gripper assembly of Claim 18, wherein said piston is configured to be moved longitudinally by exposing said piston to pressurized fluid.

20. The gripper assembly of Claim 18, said piston having a retraction side and an actuation side, wherein pressurized fluid on said retraction side of said piston exerts a pressure force onto said piston that tends to cause said ramp to move toward said first position thereof to move said gripper assembly to said retracted position, and wherein pressurized fluid on said actuation side of said piston exerts a pressure force onto said piston that tends to cause said ramp to move toward said second position thereof to move said gripper assembly to said actuated position.

21. The gripper assembly of Claim 10, wherein as said gripper assembly moves from said retracted position to said actuated position, said second toe support slides longitudinally along said mandrel toward said first toe support.

22. The gripper assembly of Claim 10, wherein said first and second toe supports have substantially constant radial positions.

23. A gripper assembly for use with a tractor for moving within a passage, said tractor having an elongated shaft, said gripper assembly having an actuated position in which said gripper assembly substantially prevents movement between said gripper assembly and an inner surface of said passage, and a retracted position in which said gripper assembly permits substantially free relative movement between said gripper assembly and said inner surface of said passage, said gripper assembly comprising:

an elongated mandrel configured to be longitudinally slidable with respect to said shaft of said tractor;

a first toe support longitudinally fixed with respect to said mandrel;

a second toe support longitudinally slidable with respect to said mandrel;

a flexible toe having a first end pivotally secured with respect to said first toe support and a second end pivotally secured with respect to said second toe support;

a piston longitudinally slidable with respect to said mandrel;

a ramp on an inner surface of said toe, said ramp sloping from a first end to a second end, said second end being radially closer to the surface of said mandrel than said first end;

a slider element longitudinally slidable with respect to said mandrel and longitudinally fixed with respect to said piston; and

a roller rotatably fixed with respect to said slider element, said roller configured to roll against said ramp;

wherein said ramp is oriented such that longitudinal movement of said slider element causes said roller to roll against said ramp to vary the radial position of said center region of said toe between a radially inner position corresponding to said retracted position of said gripper assembly and a radially outer position corresponding to said actuated position of said gripper assembly, said piston and said slider element being movable between first and second longitudinal positions relative to said mandrel, such that when said piston and said slider element are in said first position said first end of said ramp bears against said roller and said gripper assembly is in said retracted position, and such that when said piston and said slider element are in said second position said second end of said ramp bears against said roller and said gripper assembly is in said actuated position.

24. The gripper assembly of Claim 23, wherein said toe comprises a single beam.

25. A gripper assembly for use with a tractor for moving within a passage, said tractor having an elongated shaft, said gripper assembly having an actuated position in which said gripper assembly substantially prevents movement between said gripper assembly and an inner surface of said passage, and a retracted position in which said gripper assembly permits

substantially free relative movement between said gripper assembly and said inner surface of said passage, said gripper assembly comprising:

- an elongated mandrel configured to be longitudinally slidable with respect to said shaft of said tractor;

- a first toe support longitudinally fixed with respect to said mandrel;

- a second toe support longitudinally slidable with respect to said mandrel;

- a flexible elongated toe having a first end pivotally secured with respect to said first toe support and a second end pivotally secured with respect to said second toe support;

- a slider element longitudinally slidable with respect to said mandrel, said slider element being longitudinally slidable between first and second positions; and

- one or more elongated toggles having first ends rotatably maintained on said slider element and second ends rotatably maintained on a center region of said toe, said one or more toggles adapted to rotate between a retracted position in which said second ends of said one or more toggles and said center region of said toe are at a radially inner level that defines said retracted position of said gripper assembly, and an actuated position in which said second ends of said one or more toggles and said center region of said toe are at a radially outer level that defines said actuated position of said gripper assembly;

wherein longitudinal movement of said slider element causes longitudinal movement of said first ends of said one or more toggles and thereby rotates said one or more toggles, wherein when said slider element is in said first position said one or more toggles are in said retracted position, and when said slider element is in said second position said one or more toggles are in said actuated position.

26. The gripper assembly of Claim 26, wherein said toe comprises a single beam.

27. A gripper assembly for anchoring a tool within a passage and for assisting movement of said tool within said passage, said gripper assembly being movable along an elongated shaft of said tool, said gripper assembly having an actuated position in which said gripper assembly substantially prevents movement between said gripper assembly and an inner surface of said passage, and a retracted position in which said gripper assembly permits

substantially free relative movement between said gripper assembly and said inner surface of said passage, said gripper assembly comprising:

- an elongated mandrel surrounding and configured to be longitudinally slidable with respect to said shaft of said tractor;

- a first toe support longitudinally fixed with respect to said mandrel;

- a second toe support longitudinally slidable with respect to said mandrel;

- a flexible elongated toe having a first end pivotally secured with respect to said first toe support and a second end pivotally secured with respect to said second toe support so that said first and second ends of said toe have an at least substantially constant radial position with respect to a longitudinal axis of said mandrel;

- a first interaction surface longitudinally slidable with respect to said mandrel, said first interaction surface being longitudinally slidable between a retraction position and an actuation position; and

- a second interaction surface on a central region of said toe, configured to interact with said driver;

wherein longitudinal movement of said first interaction surface causes interaction between said first and second interaction surfaces substantially without sliding friction therebetween, said interaction varying the radial position of said central region of said toe, wherein when said first interaction surface is in said retraction position said central region of said toe is at a first radial distance from said longitudinal axis of said mandrel and said gripper assembly is in said retracted position, and when said first interaction surface is in said actuation position said central region of said toe is at a second radial distance from said longitudinal axis and said gripper assembly is in said actuated position.

28. A failsafe assembly for retracting a gripper portion of a downhole tool from an inner surface of a passage, said gripper portion having an actuated position in which said gripper portion substantially prevents movement between said gripper portion and said inner surface, and a retracted position in which said gripper portion permits substantially free relative movement between said gripper portion and said inner surface, said failsafe assembly comprising:

a piston configured to control the actuation and retraction of said gripper portion, said piston having an actuation position in which said gripper portion is in its actuated position, said piston having a retraction position in which said gripper portion is in its retracted position;

an actuation chamber configured so that fluid in said actuation chamber exerts a pressure force on said piston which tends to move said piston to said actuation position;

a retraction chamber configured so that fluid in said retraction chamber exerts a pressure force on said piston which tends to move said piston to said retraction position;

a high pressure fluid chamber;

an exhaust chamber in fluid communication with the exterior of said tool;

a failsafe valve in fluid communication with said actuation, retraction, high pressure, and exhaust chambers, said failsafe valve having a first position in which said failsafe valve permits fluid communication between said high pressure fluid chamber and said actuation chamber and also between said retraction chamber and said exhaust chamber, said failsafe valve having a second position in which said failsafe valve permits fluid communication between said high pressure fluid chamber and said retraction chamber and also between said actuation chamber and said exhaust chamber, said failsafe valve having a surface exposed to said high pressure fluid chamber so that fluid in said high pressure fluid chamber exerts a pressure force onto said surface of said failsafe valve which tends to move said failsafe valve to said second position thereof;

a restraint in contact with said failsafe valve and configured to maintain said failsafe valve in said first position thereof so that said failsafe valve will remain in said first position until said pressure force onto said surface of said failsafe valve exceeds a threshold pressure;

wherein when said failsafe valve is in said first position thereof and when fluid pressure in said high pressure fluid chamber exceeds said threshold pressure, said failsafe valve moves to said second position thereof so that fluid in said high



pressure fluid chamber flows into said retraction chamber to move said piston to said retraction position and said gripper portion to said retracted position thereof, and so that fluid in said actuation chamber flows to said exhaust chamber.

29. The failsafe assembly of Claim 28, wherein said failsafe valve comprises a spool valve.

30. The failsafe assembly of Claim 29, wherein said restraint comprises a protrusion on said spool valve.

31. The failsafe assembly of Claim 30, wherein said restraint comprises a dent on said spool valve.

32. The failsafe assembly of Claim 28, wherein said gripper portion comprises a flexible beam configured to bend radially from said tool and contact said inner surface of said passage.

33. An expansion assembly for use in a wellbore comprising:  
an elongate body;

a first support coupled to said body;

a second support coupled to said body;

a flexible elongate toe having a first end pivotally secured with respect to said first support and a second end pivotally secured with respect to said second support, said flexible elongate toe having an inner surface formed with at least one ramp; and

a driver longitudinally slidably coupled to said body;

wherein longitudinal movement of said driver relative to said body causes said driver to act on said ramp for causing a central region of said flexible elongate toe to extend radially outward relative to said body.

34. The expansion assembly of Claim 33, wherein said first support is longitudinally fixed with respect to said body.

35. The expansion assembly of Claim 34, wherein said second support is longitudinally slidably coupled to said body.

36. The expansion assembly of Claim 33, further comprising at least one roller mounted on said driver for interacting with said ramp, said roller configured to roll along said ramp.

37. An expansion assembly for use in a wellbore comprising:  
an elongate body;  
a first support coupled to said body;  
a second support coupled to said body;  
a flexible elongate toe having a first end pivotally secured with respect to said first support and a second end pivotally secured with respect to said second support;  
and  
a driver longitudinally slidably coupled to said body, said driver having at least one portion formed with a ramped surface;  
wherein longitudinal movement of said driver relative to said body causes said driver to act on flexible elongate toe for causing a central region of said flexible elongate toe to extend radially outward relative to said body.

38. The expansion assembly of Claim 37, wherein said first support is longitudinally fixed with respect to said body.

39. The expansion assembly of Claim 38, wherein said second support is longitudinally slidably coupled to said body.

40. The expansion assembly of Claim 37, further comprising at least one roller mounted on said flexible elongate toe for interacting with said driver, said roller configured to roll along said ramp.